Effect of compost amendment on turfgrass establishment, soil nutrient pools, and nematode community in tall fescue lawns established on topsoil and subsoil

Zhiqiang Cheng and Parwinder S. Grewal

Environmental Science Graduate Program, Department of Entomology,

The Ohio State University, OARDC, Wooster, OH 44691 USA

Abstract

Lawns have become a central part of urbanized landscapes throughout North America, providing many social and environmental benefits. However, turfgrass lawns often require excessive fertilizer inputs, which can cause stream and water quality deterioration due to runoff. We hypothesized that lawns established on subsoil have food webs that are suboptimum for nutrient mineralization, thus requiring excessive application of fertilizers. Therefore, we studied the effect of compost amendment on soil nutrient pools, soil food web, and turfgrass establishment in tall fescue lawns established on topsoil and subsoil. Plots were established by excavating soil to a depth of 15 inches and then refilling with native subsoil or topsoil with or without compost addition. There were 12 replications per treatment, and the 4 treatments were arranged in a randomized block design. Turfgrass establishment was evaluated two months after seeding and soil samples were collected pre- and post-turfgrass establishment to analyze soil nutrient pools, and nematode community as an indicator of the soil food web. Turfgrass establishment was initially better on topsoil compared to subsoil plots, but weed intensity was much higher in topsoil than subsoil plots. Macro-nutrients P and Ca, Total C, Total N, NO_3-N, and soil organic matter were higher in topsoil than in subsoil plots, and were generally increased by compost. After turfgrass establishment, nematode abundance and food web enrichment index were higher in the compost-amended plots, but maturity index was lower. Nematode genus diversity, evenness, richness, and food web structure index were higher in topsoil than in subsoil treatment.

Introduction

> Lawns control soil erosion, reduce run-off and leaching, contribute to carbon sequestration, mitigate heat island effect, and provide spaces for recreation (Beard and Green, 1994. J. Environ. Qual. 23, 452-460).

> However, urban lawns are often established on subsoil due to negligence of urban developers.

> We predict that soil food webs in urban lawns established on subsoil are under-developed leading to sub-optimum nutrient mineralization.

> As nematode community can provide a comprehensive assessment of soil food web (Ritz and Trudgill, 1999. Plant and Soil, 212, 1-11), we used nematode community indices to assess soil food web in tall fescue lawns established on subsoil or topsoil.

> We also tested the effect of compost on turfgrass establishment, soil nutrient pools, and nematode community in lawns established on topsoil and subsoil.

Hypotheses

> Subsoil has lower nutrient pools compared to topsoil.

> Nematodes are more abundant and nematode food web is more structured in turf lawns established on topsoil compared to subsoil.

> Compost amendment enhances soil nutrient pools, and builds the soil food web.

Experimental Design & Methods

> Plot establishment and treatments:

Forty-eight 2.1m by 1.7m plots were established by excavating soil to a depth of 15 inches and then refilling with native subsoil (below 12 inches) and topsoil (top 0-6 inches), with or without compost (a mixture of sawdust and a by-product of wastewater treatment), mixed at 4:1 ratio. Thus, 4 treatments, subsoil (S), subsoil+compost (SC), topsoil (T), and topsoil+compost (TC), each with 12 replications, were arranged in a randomized block design.

Entophytic tall fescue seeds were applied at the rate of 0.035 kg/m^2, and plots were covered with a water-through fabric to minimize soil moisture loss and prevent weed invasion during germination.

Plots were watered daily except when there was rain.

> Sampling schedule, data collection and analysis:

Soil samples were collected before seeding (May 2006) and two months after seeding (July 2006) to analyze soil nutrient pools and nematode community.

Soil nematodes were extracted using the Baermann funnel technique, and were identified to the genus level.

Nematode abundance, genus number, nematode genus richness, diversity, evenness, Enrichment Index, Structure Index, Maturity Index, and Plant-parasitic Index were calculated (Nahar et al., 2006. Appl. Soil Ecol. 34, 140-151; Ferris et al., 2001, Appl. Soil Ecol. 18, 13-29).

Initial soil pH, Ca, P, K, Mg, Total C, Total N, NO_3-N and soil organic matter (SOM) contents were determined using standard methods. Also SOM, NH_4-N, NO_3-N, dissolved organic nitrogen, and microbial biomass N were measured both pre- and post- turfgrass establishment.

Turfgrass establishment was recorded by estimating percentage bareground, and turfgrass and weed cover.

All data were subjected to ANOVA using SAS 9.1, and $p<0.05$ was considered as significant.

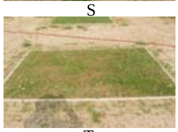
Results

Turfgrass establishment:

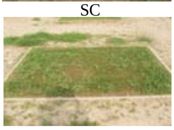
Two weeks after seeding, T and TC had higher grass cover compared to S and SC treatments, but weed intensity was much higher in T and TC than S and SC treatments (see pictures below, taken 2 weeks after seeding). But two months after seeding, turfgrass coverage on subsoil and subsoil+compost plots became higher due to lower weed intensity.

S

SC



T



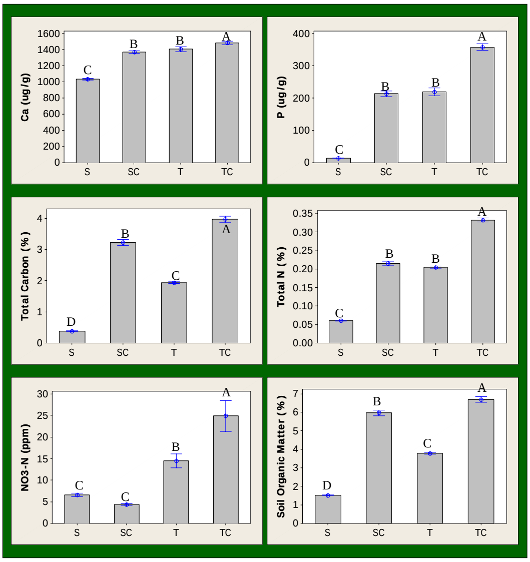
TC

Pre-turf establishment soil nutrient pools and nematode community

> The initial Ca, P, Total C, Total N, NO_3-N and SOM contents were significantly higher in topsoil than in subsoil treatments (Plate 1).

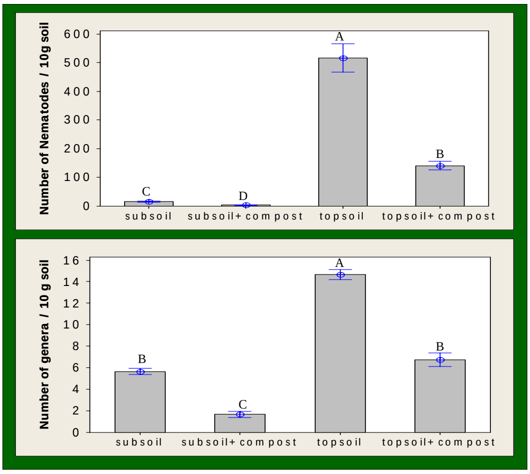
> Compost amendment significantly increased initial Ca, P, Total C, Total N, and SOM in both subsoil and topsoil treatments (Plate 1).

Plate 1. Soil analysis: pre-turf establishment



> Initial nematode abundance and genus number were significantly higher in topsoil than in subsoil treatments, but were lower in treatments with compost amendment than those without (Plate 2). There were too few nematodes in subsoil plots to calculate meaningful food web indices.

Plate 2. Nematode abundance & genera: pre-turf establishment



Post-turf establishment soil nutrient pools and nematode community

> NO_3-N, microbial biomass N, and SOM were significantly higher in topsoil than in subsoil treatments. Compost amendment significantly enhanced microbial biomass N and SOM in both top and subsoil (Plate 3).

> Nematode genus diversity, evenness, and richness indices were highest in topsoil plots (Plate 4).

> Food web structure index were higher in topsoil than in subsoil treatment (Plate 4).

> Nematode abundance and food web enrichment index were higher in the compost-amended plots, but maturity index was lower. (Plate 4).

Plate 3. Soil analysis: post-turf establishment

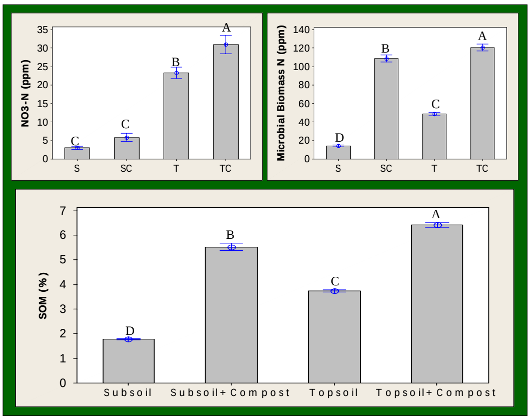
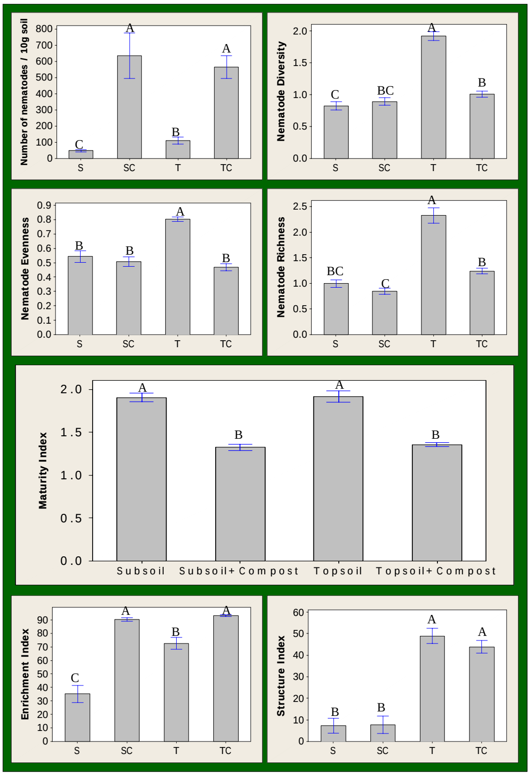


Plate 4. Nematode indices: post-turf establishment



Conclusions

> Turfgrass establishment was initially better on topsoil plots compared to subsoil plots, but topsoil plots were invaded rapidly by weeds. Weed intensity was lower in subsoil plots than topsoil plots, probably due to the lack of weed seed bank.

> Macro-nutrients P and Ca, Total C, Total N, NO_3-N, and SOM were higher in topsoil plots compared to subsoil plots, and were generally increased by compost amendment.

> Initial nematode abundance was much higher in topsoil compared to subsoil, but was temporarily reduced by compost amendment in both subsoil and topsoil.

> Two months after seeding, nematode abundance and food web enrichment index were higher in the compost-amended plots, but maturity index was lower.

> Nematode genus diversity, evenness, richness, and food web structure index were higher in topsoil than in subsoil treatment.

Acknowledgements

We thank Dr. McCoy for advice on compost, OARDC Physical Operations staff and the Grewal Lab for help with plot set-up and maintenance, and David McCartney, Donald Beam, and Senetta Bancroft for help with soil analysis.